



# ENVI® 5.7 Functional Summary

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## ENVI System Requirements

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ENVI has the following system requirements:

- **Operating systems:**
  - Windows 10 and 11 (Intel/AMD 64-bit)
  - macOS 11.5 and 12 (M1 and Intel 64-bit)
  - Linux (Intel/AMD 64-bit, kernel 4.18.0 or higher and glibc 2.28 or higher)
- **Disk space:** Approximately 4 GB for installation
- **Memory (RAM):** Minimum of 8 GB
- **Number of processing cores:** Minimum of 2, recommended 4 or more
- **Graphics card:** Minimum of 1 GB RAM and support for OpenGL 2.0 or later

### Details

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ENVI 5.7 has been tested with ArcGIS Pro version 3.0.

An X-Windows manager is required for macOS. ENVI was tested using XQuartz 2.8.5.

A Rosetta 2 emulator is required for Mac M1.

Recommending the best hardware configuration for ENVI is difficult, as hardware needs vary depending on the type of processing that is anticipated. The following are items to consider when selecting a system configuration for use with ENVI.

#### Disk space

The amount of hard-drive space that is needed for ENVI depends on the specific workflows and data that will be used. Our technical support group uses systems with 1 TB of disk space, which is more than adequate for day-to-day use. However, this would not address the needs of a production facility that processes large amounts of data on a daily basis.

A solid-state drive (SSD) is highly recommended for optimal performance.

#### Memory (RAM)

Most image display and processing capabilities in ENVI and IDL have been designed to work with minimal amounts of system RAM. Having a lot of RAM can help to avoid occasional memory allocation problems, especially with large datasets. Tests have shown that 8 GB of

RAM is adequate for most tasks run using the latest versions of ENVI and IDL. However, if you anticipate working with very large datasets, or if you are building custom applications with ENVI+IDL code, then you may consider adding more RAM to your system.

### Graphics card

For optimal performance, your graphics card should have a minimum of 1 GB RAM and should support OpenGL 2.0 or later. Also be sure to install the latest drivers for your graphics card. If you anticipate implementing sophisticated graphical displays while building custom applications in ENVI+IDL—or if you expect to work with large datasets—then the more RAM the better.

### Processors and Cores

ENVI only supports CPUs with the Advanced Vector Extensions (AVX) instruction set. In general, any CPU after 2011 will contain this instruction set.

## Supported Data Types

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The following table lists the data types that ENVI supports.

- A separate NITF/NSIF license is required to view NITF files.
- See the *ENVI System Requirements* topic in ENVI Help for supported versions of ArcGIS Pro.

### Raster Formats

<b>Data Type</b>	<b>Read</b>	<b>Write</b>
ADS40 (TIFF)	•	
ADS80 (TIFF)	•	
AIRSAR (JPL Stokes matrix format)	•	
AISat-2A (TIFF)	•	
ALOS Level-1B2 AVNIR-2	•	
ALOS Level-1A and 1B1 AVNIR-2	•	
ALOS Level-1A and 1B1 PRISM	•	
ALOS Level-1B2 PRISM	•	
ALOS-1 and -2 PALSAR (CEOS)	•	
ArcGIS Image Services (JPEG, TIFF, PNG)	•	
ArcGIS Mosaic datasets (JPEG, TIFF, PNG)	•	
ArcView Raster (BIL)	•	•
ASCII (x,y,z and gridded)	•	•
ASTER Level-1A and 1B (HDF-EOS)	•	
ASTER Level-2 (HDF-EOS)	•	
ASTER Level-3 DEM (HDF-EOS)	•	
ATSR GBT, GBROWSE, GSST	•	
AVHRR KLMN Level-1B	•	
AVHRR SHARP (ESA)	•	
AVHRR Quorum (HRPT)	•	
AVIRIS	•	
BigTIFF	•	•
Binary	•	
Bitmap (BMP)	•	

<b>Data Type</b>	<b>Read</b>	<b>Write</b>
CADRG	•	•
Cartosat-1 (TIFF)	•	
CIB	•	•
Cloud Optimized GeoTIFF	•	•
COSMO-SkyMed Level-1A SCS, 1B DGM, 1C GEC, 1D GTC (HDF5)	•	
Deimos-1	•	
Deimos-2	•	
DigitalGlobe / Maxar Analysis Ready Data (ARD)	•	
DMC UK-DMC Level-1R, 1T, 2R (TIFF)	•	
DMC UK-DMC2 Level-1R, 1T, 2R (TIFF)	•	
DMC ALSAT-1 Level-1R, 1T (TIFF)	•	
DMC Beijing-1 Level-1R, 1T (TIFF)	•	
DMC NigeriaSat-1 Level-1R, 1T (TIFF)	•	
DMC NigeriaSat-2 Level-1R, 1T (TIFF)	•	
DMSP	•	
DPPDB (NITF)	•	
DTED Level-0, 1, 2	•	•
DubaiSat-1 (TIFF)	•	
DubaiSat-1 (RAW)	•	
DubaiSat-2 (TIFF)	•	
ECRG	•	
ECW	•	
EMIT (Level 1B, Level 2A)	•	
EnMAP (Level-1B, Level-1C, Level-2A)	•	
ENVI classification file	•	•
ENVI feature counting file	•	•
ENVI meta file	•	•
ENVI raster	•	•
Envisat AATSR Level-1B and 2	•	
Envisat ASAR Level-1B	•	
Envisat MERIS Level-1B and 2	•	
EO-1 ALI (HDF4)	•	
EO-1 ALI Level-1T (GeoTIFF)		
EO-1 Hyperion Level-1R (HDF)	•	
EO-1 Hyperion Level-1T (GeoTIFF)	•	

<b>Data Type</b>	<b>Read</b>	<b>Write</b>
ER Mapper (unsigned integer data)	•	•
ERDAS IMAGINE	•	•
EROS A Level-1A	•	
EROS A Level-1B (GeoTIFF)	•	
ERS-1 Level-0, SLC (CEOS generic)	•	
ERS-2 Level-0, SLC (CEOS generic)	•	
Esri GRID (single band)	•	
Esri GRID Stack 7.x (multispectral)	•	
FormoSat-2	•	
FormoSat-5	•	
Gaofen-1	•	
Gaofen-2	•	
GeoEye-1 (NITF)	•	
GeoEye-1 (GeoTIFF)	•	
GeoEye-1 (DigitalGlobe format)	•	
GIF	•	
GeoTIFF	•	•
GOES-16 (NetCDF-4)	•	
GOES-17 (NetCDF-4)	•	
Göktürk-1 and Göktürk-2 (GeoTIFF)	•	
GRIB-1	•	
GRIB-2	•	
HDF-EOS	•	
HDF4	•	
HDF5	•	
Himawari-8 (NetCDF-3)	•	
IKONOS (NITF)	•	
IKONOS (GeoTIFF)	•	
JERS-1	•	
JPEG	•	
JPEG2000	•	•
JPIP (JPEG2000)	•	
KOMPSAT-2 (GeoTIFF)	•	
KOMPSAT-3 (GeoTIFF)	•	
KOMPSAT-3A (GeoTIFF)	•	

<b>Data Type</b>	<b>Read</b>	<b>Write</b>
Landsat 4, 5 TM files with Metadata (GeoTIFF)	•	
Landsat 7 ETM+ files with Metadata (GeoTIFF)	•	
Landsat 7 Fast Pan data, Band 8	•	
Landsat 7 Fast VNIR/SWIR data, Bands 1-5 and 7	•	
Landsat 7 Fast Thermal data, Bands 61-62	•	
Landsat 8 OLI/TIRS files with Metadata (GeoTIFF)	•	
Landsat 8 Surface Reflectance	•	
Landsat 9 OLI/TIRS files with Metadata (GeoTIFF)	•	
Landsat ACRES CCRS	•	
Landsat Analysis Ready Data	•	
Landsat ESA CEOS	•	
Landsat L2SP	•	
Landsat Level-3 Products	•	
Landsat TM Fast	•	
Landsat HDF4	•	
Landsat MRLC	•	
Landsat NLAPS	•	
LAS LiDAR versions 1.0 through 1.4	•	
MASTER (HDF4)	•	
Meteosat 2nd generation (Level 1.5)	•	
MIE4NITF	•	
MODIS Level-1B through 4 (HDF-EOS)	•	
MrSID (Windows and Linux only)	•	
Multi-page TIFF	•	
NetCDF-3	•	
NetCDF-4	•	
NigeriaSat-1 (TIFF)	•	
NigeriaSat-2 (TIFF)	•	
NITF 1.1 (license required)	•	
NITF 2.0 (license required)	•	•
NITF 2.1 (license required)	•	•
NSIF 1.0 (license required)	•	•
NPP VIIRS (HDF5)	•	
OGC WCS (GIF, JPEG, PNG, TIFF/GeoTIFF)	•	

<b>Data Type</b>	<b>Read</b>	<b>Write</b>
OGC WMS (GIF, JPEG, PNG, TIFF/GeoTIFF)	•	
OrbView-3 (NITF, TIFF)	•	
PCI	•	•
PDS	•	
PeruSat-1	•	
PICT	•	
PlanetScope	•	
Pleiades-HR 1A, 1B Primary and Ortho	•	
Pleiades-HR DIMAP V1	•	
Pleiades-HR DIMAP V2 (JPEG2000, TIFF)	•	
Pleiades-HR Mosaic Tiles	•	
Pleiades-NEO	•	
PNG	•	
PRISMA	•	
Proba-V (HDF5)	•	
QuickBird (DigitalGlobe format)	•	
QuickBird (NITF)	•	
QuickBird (GeoTIFF)	•	
RADARSAT-1 (CEOS)	•	
RADARSAT-2 (GeoTIFF)	•	
RapidEye Level-1B Basic (NITF, GeoTIFF)	•	
RapidEye Level-3A Ortho (NITF, GeoTIFF)	•	
RapidEye Level-3B Area-based Ortho (GeoTIFF)	•	
RASAT	•	
ResourceSat-1 Fast	•	
ResourceSat-1 Super Structured	•	
ResourceSat-2 (HDF5)	•	
SeaWiFS LAC 1B, 2A, 2B (CEOS)	•	
SeaWiFS Level-1A, 1B (HDF4)	•	
Sentinel-2	•	
Sentinel-3	•	
SICD (NITF SAR)	•	
SIR-C / X-SAR	•	
SkySat	•	
SPOT ACRES	•	



<b>Data Type</b>	<b>Read</b>	<b>Write</b>
SPOT CAP	•	
SPOT GeoSPOT	•	
SPOT Level-1A, 2A, 1B	•	
SPOT mosaic tiles	•	
SPOT 2-5 DIMAP V1 (BIL, TIFF)	•	
SPOT 6 DIMAP V2 (JPEG2000, TIFF)	•	
SPOT 7 DIMAP V2 (JPEG2000, TIFF)	•	
SPOT SISA	•	
SPOT Vegetation (HDF4)	•	
SRF	•	
SRTM DEM	•	
SSOT DIMAP V2	•	
STANAG 4676 Track Points, Edition B	•	
SuperView-1 (Level-1B and Level-2A multispectral and panchromatic data)	•	
TFRD (license required)	•	
TIFF	•	•
Multi-page TIFF	•	
TIMS	•	
TOPSAR Correlation Image, Incidence Angle, DEM	•	
TripleSat (DIMAP)	•	
TripleSat (XML)	•	
UrtheCast Theia	•	
USGS DOQ	•	
USGS DRG	•	
USGS Native DEM	•	
USGS SDTS DEM	•	
VNREDSat-1	•	
WorldView-1 (DigitalGlobe format)	•	
WorldView-1 (NITF)	•	
WorldView-1 (GeoTIFF)	•	
WorldView-2 (DigitalGlobe format)	•	
WorldView-2 (NITF)	•	
WorldView-2 (GeoTIFF)	•	
WorldView-3 (DigitalGlobe format)	•	

<b>Data Type</b>	<b>Read</b>	<b>Write</b>
WorldView-3 (NITF)	•	
WorldView-3 (GeoTIFF)	•	
WorldView-4 (DigitalGlobe format)	•	
WorldView-4 (NITF)	•	
WorldView-4 (GeoTIFF)	•	
XWD	•	
Zhuhai-1	•	
Ziyuan-1-02C	•	
Ziyuan-3A	•	

## Vector Formats

<b>Data Type</b>	<b>Read</b>	<b>Write</b>	<b>Remote</b>
ENVI vector format (EVF)	•	•	
Esri Shapefile (excluding Z and M polygons)	•	•	
OGC GeoPackage vector file (.gpkg)	•		

## Video Formats

The combination of video file format and codec used for video streaming determines whether ENVI can read a particular video file.

<b>Data Type</b>	<b>Read</b>	<b>Write</b>	<b>File to Select</b>
Adobe Flash (FLV)	•	•	.f4v, .flv
Adobe Shockwave Flash (SWF)	•	•	.swf
Animated GIF	•	•	.gif
Apple QuickTime	•	•	.mov
Audio Video Interleaved (AVI)	•	•	.avi
DV (Linux only)	•	•	.dv
Google WebM Matroska	•	•	.webm
Matroska Video	•	•	.mkv
Motion JPEG	•	•	.mjpeg, .mjpg
Motion JPEG2000	•		.mj2

<b>Data Type</b>	<b>Read</b>	<b>Write</b>	<b>File to Select</b>
MPEG-1 Part 2	•		.mpeg, .mpg, .mp1, .m2v
MPEG-2 Transport Stream	•		.ts
MPEG-2 Part 2	•		.mpeg, .mpg, .mp2, .mpg2, .mpeg2, .mpv, .m2v
MPEG-4 Part 12 / 3GPP / 3GPP2			.3gp, .3g2
MPEG-4 Part 14	•	•	.h264, .mp4, .mpeg4, .mpg4, .mp4
RAW	•	•	.raw

### Video Codec Formats

Codecs are used to encode data streams for transmission, storage, or encryption; and to decode the data streams for video playback.

<b>Name</b>	<b>Description</b>	<b>Read</b>	<b>Write</b>
BMP	Bitmap (Windows only)	•	
FLV	Adobe Flash Video: FLV Sorenson Spark Sorenson H.263	•	•
GIF		•	•
H.263	H.263-1996 H.263+ H.263-1998 H.263 Version 2	•	•
H.264	MPEG-4 Part 10: H.264 AVC	•	
HEVC	High Efficiency Video Coding	•	
MJPEG	Motion JPEG	•	•
MPEG1 Video	MPEG-1: H.261	•	
MPEG2 Video	MPEG-2: H.222 H.262	•	•
MPEG4	MPEG-4 Part 2	•	•

<b>Name</b>	<b>Description</b>	<b>Read</b>	<b>Write</b>
MSMPEG4V1	MPEG-4 Part 2 Microsoft Variant Version 1	•	•
MSMPEG4V2	MPEG-4 Part 2 Microsoft Variant Version 2	•	•
MSMPEG4	MPEG-4 Part 2 Microsoft Variant Version 3	•	•
RAW	Raw video (uncompressed)	•	•
VC-1	Microsoft codec, also known as SMPTE 421M	•	
VP8	Google codec	•	

## ENVI Functional Summary

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This document lists all of the capabilities that the current version of ENVI provides.

See the following sections:

- [Supported Data Types](#)
- [Add-on Modules](#)

The following sections list ENVI functionality by specific category:

- [Annotation and Map Composition](#)
- [Change Detection](#)
- [Classification](#)
- [Display Tools](#)
- [ENVI Modeler](#)
- [ENVI Server](#)
- [Filters](#)
- [Geographic Positioning Tools](#)
- [Image Transforms](#)
- [LiDAR Analysis](#)
- [Metadata](#)
- [Preprocessing and Calibration](#)
- [Programming API](#)
- [Radar Analysis](#)
- [Regions of Interest](#)
- [Spectral Analysis](#)
- [Statistics](#)
- [Target Detection](#)
- [Time Series Analysis](#)
- [Topographic Modeling](#)

- [Vectors and GIS Support](#)
- [Vegetation Analysis](#)

Also consult the following topics in ENVI Help:

- *ENVI System Requirements*: Supported operating systems and recommended hardware configurations
- *ENVI Feature Support*: Features that are only supported on certain operating systems
- *Getting Started with ENVI*: A more in-depth summary of ENVI functionality for new users

## Supported Data Types

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See the Supported Data Types topic in ENVI Help for an extensive list of raster, vector, and video data types that ENVI reads and writes.

The following are specialized tools for working with specific data types:

### Dataset Browser

Add custom metadata

Build ENVI Meta files

Build new rasters using a combination of bands and metadata fields

Create templates

Change interleave

Export dataset structures to XML, JSON, or text

Flip images vertically

Read HDF4 and HDF5 files

Read HDF-EOS files

Read NetCDF-3 and NetCDF-4 files

View metadata

### Full Motion Video

Display Motion Imagery Standards Board (MISB) metadata

Export entire videos to an ENVI raster series

Export frames to Google Earth

Export individual frames to ENVI raster format

Load frames to the ENVI view

Play and pause video frames

Plot metadata values over time

Rotate video frames to North up

Set display options and frame rates for viewing videos

Use bookmarks to manage points of interest in a video

View frames in separate ENVI views

### NITF Dataset Browser

An ENVI NITF license is required to use these features.

Copy metadata to system clipboard

Edit select metadata fields

Load camera frames to the ENVI view

Load image segments to the ENVI view

Read NITF 1.0, 1.1, 2.1 files

Read MIE4NITF files

Save metadata

Subset camera frames (MIE4NITF)

View global metadata

View segment-specific metadata

View tagged record extension (TRE) fields

Xtreme Viewer for fast animation of MIE4NITF frames

### Remote Connection Manager

Connect to ArcGIS Image Services

Connect to Jagwire servers

Connect to Open Geospatial Consortium (OGC) datasets

- Web Coverage Service (WCS) versions 1.0.0, 1.1.0, 1.1.1, 1.1.2, 2.0.1
- Web Feature Service (WFS) versions 1.1 and 2.0
- Web Mapping Service (WMS) 1.3.0
- Web Map Tile Service (WMTS) 1.0.0

Open Remote Dataset dialog: use to connect to all of the above, plus JPEG2000 Interactive Protocol (JPIP) servers.

## Add-on Modules

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Atmospheric Correction: QUAC® and FLAASH®

DEM Extraction

Deep Learning, including Machine Learning

Feature Extraction

NITF

Photogrammetry

## Annotation and Map Composition

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Add annotations to the display:

- Arrows
- Classification legends
- Color Bars
- Ellipses
- Grid lines
- Image magnifiers
- Pictures
- Plots
- Points, polylines, polygons
- Range rings
- Rectangles
- Scale bars



- Symbols
- Text

Affix annotations to the display so they remain stationary when rotating or zooming

Create and save annotation layers

Edit annotation properties

Interactively resize and reposition annotation items

Overlay contour lines

Scale annotations while zooming in or out of the display

## Band Math and Spectral Indices

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Combine ENVI Band Math with IDL to create powerful mathematical operations on pixel data

Choose from 100 pre-built spectral, vegetation, and mineral indices to indicate the relative abundance of features

Create color composites from image bands

Use band ratios to enhance the spectral differences between bands

## Change Detection

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Change Detection Workflow

Quick thematic change detection

Image Change Workflow

Show changes between two images:

Automatically coregister images

Specify image differencing methods:

- Feature index: NDVI, NDWI, NDBI, Burn index
- Input band
- Spectral angle

Specify image transform methods:

- Independent Component Analysis (ICA)
- Minimum Noise Fraction (MNF)
- Principal Components Analysis (PCA)

Specify the type of change to show:

- Decrease only
- Increase only
- Increase and decrease

Apply thresholding: Automatic or manual

Export class statistics to text file

Export class vectors to shapefile

Export classes to ENVI classification image

Export grayscale change image to ENVI or TIFF

Smooth and/or aggregate image change results

Specify reprojection, resampling, and warping methods

### Thematic Change Workflow

Export classes to ENVI classification image

Export class vectors to shapefile

Export class statistics to text file

Show changes between thematic classes

Show class transitions

Smooth and/or aggregate thematic change results

Specify reprojection methods

## Classification

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Perform decision tree classification

Perform supervised classification:

- Adaptive Coherence Estimator (ACE)
- Binary Encoding

- Constrained Energy Minimization (CEM)
- Mahalanobis Distance
- Maximum Likelihood
- Minimum Distance
- Orthogonal Subspace Projection (OSP)
- Parallelepiped
- Spectral Angle Mapper (SAM)
- Spectral Information Divergence (SID)
- Support Vector Machine (SVM)

Perform unsupervised classification:

- ISODATA
- K-Means

Perform post-classification tasks:

- Aggregate classes
- Calculate confusion matrices
- Clump classes
- Combine classes
- Convert classes to pixel ROIs
- Convert classes to polygon ROIs
- Convert rule images to classes
- Create buffer zone images
- Display ROI curves
- Edit classification images
- Export classes to vector layers
- Generate random samples
- Run majority and minority analyses
- Sieve classes

- Calculate statistics for classes
- Classify lines of communication for roads and water (SPEAR Tools)
- Edit class layer names and colors

## Deep Learning

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An ENVI Deep Learning license is required to use these features.

Create class activation (heat map) images of features using trained models

Create classification images of features using trained models

Convert class activation images to shapefiles and ROIs

Deep Learning Labeling tool to collect training samples in imagery

Deep Learning Guide Map walks through the entire process

Find one or multiple features in imagery

Train TensorFlow models to identify features of interest

View real-time training metrics in TensorBoard

View model metadata and accuracy metrics

## Display Tools

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Animate bands

Apply color tables

- Adjust gradients
- Choose from predefined options
- Define color spaces: RGB, HLS, HSV

Apply custom histogram stretches

Apply quick stretches:

- Bipolar
- Equalization
- Gaussian
- Linear

- Linear 1%, 2%, 5%
- Logarithmic
- Optimized Linear
- Square Root

Blend data layers

Chip views to:

- File: ENVI, JPEG, JPEG2000, NITF, TIFF
- Geospatial PDF
- Google Earth
- PowerPoint: Configure and use PowerPoint templates

Count image features:

- Count up to 5000 individual features in raster and vector data
- Define separate feature types
- Edit properties
- Export features to CSV, ROI, shapefile, text
- Manage feature records
- Overlay grids
- Save and restore feature counting files

Create color slices:

- Calculate class statistics
- Define custom slices
- Export slices to classification image or shapefile
- Interactively edit slices

Create shapefiles of contour lines from full-resolution images

Create data profiles:

- Arbitrary (transect)
- Spatial

- Spectral
- Time Series

Display dataset properties

Display different band combinations:

- Color-infrared
- Custom
- True-color

Display reference maps showing the extent of data layers

Dock and undock panels

Drag and drop files from/to:

- Data Manager
- File system
- Windows explorer

Enhance views:

- Brightness
- Contrast
- Quick stretches
- Sharpen
- Transparency

Expand and collapse Layer Manager and Toolbox

Export views to:

- Geospatial PDF
- Images: ENVI, TIFF

Export layers to TIFF

Flicker between data layers

Geographically link data with ArcGIS Pro

Send data to ArcGIS Pro

Go to specific locations:

- Map coordinates
- Pixel coordinates

Manage views:

- Change background color
- Establish zoom links between views
- Link views by geographic location or pixel
- Quick link views
- Save and restore views
- Set up multiple views: Preset or custom number
- Specify base projection
- North up
- Up is up
- Shadows down

Measure distances (mensuration)

Navigate data layers:

- Fly
- Pan
- Scroll through views

Plot data values

Query cursor locations:

- Report data values
- Report sub-pixel file and/or map coordinates
- Report vector information

Reorder data layers

Rotate the display

Send files to ArcGIS Pro

Show an overview window:

- Locator rectangle
- Snail trail
- Save snail trail to TIFF file

Show and hide individual data layers

Stretch views by:

- Full extent
- View extent
- View extent with automatic update

Swipe data layers

Use portals to see through underlying data layers

Watch the progress of multiple processes that are running

Zoom in and out of views

## ENVI Modeler

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Add conditional statements

Add breakpoints to pause models at certain points during execution

Add comments to models

Batch-process multiple datasets

Build models using a simple user interface

Create metatasks

Create task-based workflows

Drag and drop model files from Windows to ENVI

Generate ENVI toolbox extensions from models

Generate IDL programs from models

Generate metatask files from models

Generate Python programs from models

Run models in a desktop or enterprise environment

Run models on ENVI Servers

Validate models before execution



## ENVI Server

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Monitor the status of running jobs

Run multiple, concurrent ENVI processes in the background

Scale processing power by setting up and using other ENVI Servers in a distributed environment

Use the ENVI Modeler to batch-process multiple datasets on different ENVI Servers

## Feature Extraction

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An ENVI Feature Extraction license is required to use these features.

Define and edit output classes

Export classes to ENVI raster file

Export classes to shapefile

Export confidence image to ENVI raster file

Export segmentation image to ENVI raster file

Export segmentation vectors to shapefile

Import ancillary data such as DEMs to improve classification

Merge adjacent segments with similar spectral attributes

Perform example-based classification:

- Choose supervised methods: KNN, PCA, SVM
- Import ground truth shapefiles
- Interactively define training data
- Save training data to shapefiles

Perform image segmentation without classification

Perform rule-based classification:

- Build rules based on spatial, spectral, and texture attributes
- Export attribute image to ENVI raster file
- Preview attribute image

Preview classification results

Save processing summary to text file

Segment images into objects with similar pixel characteristics

Use individual tools or end-to-end, guided workflows

## Filters

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Apply adaptive filters:

- Bit Error
- Enhanced Frost
- Enhanced Lee
- Frost
- Gamma
- Kuan
- Lee: Additive, multiplicative, additive-multiplicative
- Local sigma

Apply convolution filters:

- Directional
- Gaussian high pass
- Gaussian low pass
- High pass
- Laplacian
- Low pass
- Median
- Roberts
- Sobel

Apply frequency (FFT) filters

Apply morphology filters:

- Binary
- Grayscale

Apply texture filters:

- First order (occurrence): Data range, entropy, mean, skewness, variance
- Second order (co-occurrence): Contrast, correlation, dissimilarity, entropy, homogeneity, mean, second moment, variance
- Label entropy
- Rank strength

## Geographic Positioning Tools

---

Automatically generate tie points by:

- Cross correlation
- Cross correlation with orthorectification
- Mutual information
- Mutual information with orthorectification

Build geometry files:

- ASTER
- AVHRR
- SeaWiFS
- SPOT

Build grid definitions from:

- Image intersection
- Image union
- The spatial information of an existing image

Build rational polynomial coefficients (RPCs) for aerial and satellite sensors

Convert ASCII coordinates from one projection to another

Convert between pixel and map coordinates

Convert map coordinates from one coordinate system to another

Correct bowtie artifacts in MODIS images

Filter tie points by:

- Fundamental matrix
- Global transform

- Global transform with orthorectification
- Pushbroom model

Generate coordinate system strings for use with the ENVI API or header files

Georeference images using input geometry files:

- Build geographic lookup tables (GLTs)
- Build super GLT files from input geometry (IGM) files
- Georeference images from GLTs
- Georeference images from super GLTs
- Georeference files from IGMs
- Reproject datasets that contain GLTs: GOES-16, GOES-17, MODIS, NPP VIIRS, PRISMA, Sentinel-3

Georeference specific sensors using dedicated tools:

- ASTER
- AVHRR
- COSMO-SkyMed
- Envisat
- MODIS
- RADARSAT
- SeaWiFS
- SPOT

Orthorectify images using RPCs:

- Use standalone tools or an end-to-end, guided workflow
- Improve overall accuracy using input GCPs
- Use a reference image to automatically create GCPs
- Overlay relative error color gradients
- Preview orthorectification results
- Export result to ENVI or TIFF
- View error metrics

Overlay grid lines on georeferenced images

Perform image-to-map registration

Perform rigorous orthorectification (requires the ENVI Photogrammetry Module)

Register images and vectors with GeoServer

Register two images to the same coordinate system using our patented registration engine

- Automatically create tie points by choosing one of four geometric models
- Export result to ENVI or TIFF
- Export tie points to text file
- Import seed tie points
- Overlay relative error color gradients
- Preview tie points in both the base and warp image
- Set warping parameters
- Use standalone tools or an end-to-end, guided workflow

Reproject images to different coordinate systems

Resample images:

- By pixel scale
- Using column and row mapping

Select from hundreds of coordinate systems using a dedicated dialog

SPEAR Coregistration

SPEAR Orthorectification

Warp and resample images

## Image Transforms

---

Apply decorrelation stretches

Apply tasseled cap transforms to Landsat images

Create pan-sharpened images:

- Gram-Schmidt
- NNDiffuse

Create spectrally sharpened images:

- Brovey color normalized
- Color normalized
- Hue/saturation/value (HSV)
- Principal components

Create synthetic color images

Enhance the color of red/green/blue (RGB) images:

- Photographic stretch
- Saturation stretch

Expand the dimensionality of images

Reduce the dimensionality of images:

- Independent Components Analysis (ICA)
- Minimum Noise Fraction (MNF)
- Principal Components Analysis (MNF)

Transform color spaces:

- HLS to RGB
- HSV to RGB
- RGB to HSV
- RGB to HLS
- USGS Munsell to HSV
- USGS Munsell to RGB

## LiDAR Analysis

---

Extract point clouds from overlapping stereo images (requires the ENVI Photogrammetry Module)

Read and convert LAS files into ENVI raster format or ENVI Vector Files (EVFs)

Use the Classic LiDAR Viewer to interactively explore point values in LAS files

View LAS header files

## ENVI LiDAR Application

Add and edit vectors after processing:

- Buildings
- Power lines

Change the point classification of contoursAdd and edit vectors after processing:

- Buildings
- Power lines

Change the point classification of contours

Color point clouds by:

- Height
- Classification
- Intensity
- RGB

Create image products from point clouds:

- Digital elevation models (DEMs)
- Digital surface models (DSMs)
- Orthophotos

Create and manage projects

Create other products from point clouds:

- Classified point clouds
- DEM contours
- Terrain TIN

Correct processed data:

- Buildings
- DEMs
- Power lines and poles
- Trees

Export products to their native formats after quality assurance (QA)

Extract landscape features from point clouds:

- Buildings
- Power lines
- Power poles
- Trees

Establish cross-sectional views

Perform quality assurance on processing results

Save and restore view locations

Transform point clouds into GIS layers

View point density maps

## Metadata

---

Edit ENVI header file metadata

Edit NITF metadata

View dataset properties and basic metadata alongside displayed data

View detailed metadata for various types of data:

- Annotations
- Classification
- NITF
- Raster
- Raster Color Slices
- Raster Series
- Temporal Cube
- Vector

## Preprocessing and Calibration

---

Also see [Image Transforms](#) and [Geographic Positioning Tools](#).

Apply gains and offsets to image bands



Apply masks to images from:

- Pixel values
- ROIs
- Vectors

Build band- and layer-stacked images

Calibrate AVHRR data from NOAA-12 through NOAA-19:

- Reflectance
- Brightness temperature
- Sea surface temperature

Calibrate NASA Thermal Infrared Multispectral Scanner (TIMS) data to radiance

Convert complex data:

- Real
- Imaginary
- Power
- Magnitude
- Phase

Convert data interleave (BSQ, BIL, BIP)

Convert between data types (floating point, integer, byte, etc.)

Correct images for atmospheric effects:

- Dark subtraction
- Emissivity and temperature correction
- Empirical line correction
- FLAASH® (requires the ENVI Atmospheric Correction Module)
- Flat field correction
- Internal Average Relative Reflectance (IAR)
- Log residuals correction
- QUAC® (requires the ENVI Atmospheric Correction Module)
- Thermal atmospheric correction for TIMS data

Correct Landsat MSS aspect and skewing issues

Create binary rasters using thresholds:

- Automatic
- Greater than
- Less than

Create cloud masks with Fmask algorithm:

- Landsat
- Sentinel-2
- NPP VIIRS Moderate Resolution (750 m)

Create ENVI Meta files

Create test images for ENVI:

- Constant value images
- Gaussian Point Spread function
- Horizontal and vertical ramps
- Random number images using both uniform and normal distributions

Create mirrored and transposed images

Create stretched images:

- Bipolar
- Equalization
- Gaussian
- Linear percent
- Linear range
- Logarithmic
- Optimized Linear
- Square Root

Define spatial subsets:

- By bounding box
- By another image's extent

- By ROI
- By shapefile

Define spectral subsets

Dice images into individual tiles:

- By distance
- By pixel count
- By tile count
- By vectors

Examine data files at the byte level

Export and/or subset image bands to IDL variables

Generate a thumbnail image

Import IDL variables into ENVI

Log residuals correction tool

Perform radiometric calibration:

- Brightness temperature
- Top-of-atmosphere (TOA) reflectance
- Radiance

Preprocessing workflow

Regrid raster to a custom grid

Remove striping artifacts from Landsat MSS data

Replace bad lines of image data

Resize and resample images

Rotate and flip images

Set data values to ignore

Suppress vegetation spectral signatures from imagery

Thermal atmospheric correction

Mosaics

Create pixel-based mosaics for non-georeferenced images

Create quick mosaics from displayed images

Create seamless mosaics:

- View and recalculate input image footprints
- Set input data values to ignore
- Perform color correction:
  - Use only the overlap area or the entire extent
  - Choose which image to use for calculating statistics
- Automatically add seamlines
- Edit seamlines
- Set the feathering distance to blend images
- Set the input scene display order
- Interactively select the output spatial extent
- Export mosaics to ENVI or TIFF

SPEAR Tools

Atmospheric Correction

Independent Components Analysis (ICA)

## Programming API

---

Batch-process data

Create custom plot functions

Create ENVI Toolbox extensions

Create custom ENVITasks:

- Incorporate existing user interface (UI) elements instead of writing UI code from scratch
- Use style sheets to control appearance

Create custom workflows

Create metatasks (tasks within tasks)

Deploy programs to cloud environments such as Geospatial Services Framework (GSF)

Manage raster metadata

Manage views and layers

Process data using ENVITasks

Run ENVI analytics at the command line:

- Bash shell scripts
- Custom tasks
- stdin, stdout, stderr
- Windows batch scripts

Use tile iterators to process large datasets

Write end-to-end classification programs:

- Randomize input data
- Scale input data
- Split data into training and validation sets
- Specify classifier methods: Softmax Regression and SVM
- Train classifiers: Iterative and gradient-descent methods
- Evaluate classifiers and produce accuracy metrics

Write error-handling code

Write event-handling code:

- Keyboard events
- Mouse events
- Selection change events

Write program notification (messaging) code

Write programs that combine IDL and ENVI functionality

## Radar Analysis

---

The ENVI SARscape module offers a comprehensive set of tools and workflows for analyzing modern radar datasets. The following tools are available in ENVI and are separate from ENVI SARscape.

Calibrate radar data to brightness values ( $\beta^0$ ) or backscatter coefficients ( $\sigma^0$ ):

- ERS Pulse Repetition Interval (PRI)
- RADARSAT Georeferenced Data (Level-1)

Calibrate radar amplitude images to sigma nought backscatter:

- ALOS-1
- ALOS-2 PALSAR Level 1.1, 1.5, 2.1, and 3.1 data

Convert complex data:

- Real
- Imaginary
- Power
- Magnitude
- Phase

Convert raw TOPSAR data files to physical units

Create AIRSAR scattering classification images

Create incidence angle images:

- AIRSAR
- RADARSAT
- SIR-C
- Generic

Create pedestal height images:

- AIRSAR
- SIR-C

Create phase images:

- AIRSAR
- SIR-C

Perform multilooking on compressed SIR-C data

Remove antenna gain variations

Resample data from slant to ground range:

- AIRSAR
- RADARSAT
- SIR-C
- Generic

Synthesize data:

- AIRSAR
- SIR-C

View headers:

- AIRSAR
- COSMO-SkyMed
- Generic CEOS
- RADARSAT

## Regions of Interest

---

Create ROIs interactively:

- From band thresholds
- From geometry
- From pixels

Grow ROIs:

- From neighboring pixels
- With the Magic Wand tool

Compute ROI separability

Compute statistics from ROIs

Convert data types to ROIs:

- ASCII
- Buffer zones
- Classes
- Feature counts

- GeoJSON features
- Vector records and attributes

Create confusion matrices from ground truth ROIs

Create receiving operating characteristic (ROC) curves from ground truth ROIs

Define spatial subsets from ROIs

Interactively draw ROIs:

- Ellipses
- Multiple objects within one ROI
- Pixels
- Polygons
- Polygons with interior spaces
- Polylines
- Rectangles

Merge ROIs

Pixelate ROIs

Report the area of ROIs

Save and export ROIs:

- Comma-separated value (CSV)
- ENVI Classic format (.roi)
- GeoJSON
- Shapefile
- XML

Send ROIs to the n-D Visualizer

Spatially subset images from ROIs

## Spectral Analysis

---

Apply EFFORT spectral polishing to apparent reflectance data

Apply mathematical expressions or IDL procedures to spectra

Classify imagery based on vegetation and ecologic health:



- Agricultural stress
- Fire fuel distribution
- Overall forest health

Create 3D image cubes from hyperspectral and multispectral bands

Find pixels that are spectrally anomalous throughout an image (Anomaly Detection)

Linear Spectral Unmixing to determine the relative abundance of materials

n-D Visualizer to assign the purest spectral endmembers to classes

Perform THOR spectral analysis using multiple standalone tools

Pixel Purity Index tool to locate the purest spectral endmembers in imagery

Relative water depth

Resample spectra to match:

- ASCII wavelength file
- Response of a known instrument
- User-defined filter functions
- Wavelengths of a specific image input file

Sequential Maximum Angle Convex Cone (SMACC) tool to find spectral endmembers and their abundances

Spectral Analyst to help identify materials based on their spectral characteristics

Spectral Hourglass Wizard to find and map image spectral endmembers:

- Specify input and output files
- Apply MNF transform to reduce data dimensionality
- Use PPT and n-D Visualizer to locate the purest spectral endmembers
- Use spectral mapping methods to map endmembers back to image pixels
- View rule images and classification results

Spectral mapping methods for use withwith hyperspectral imagery:

- Continuum Removal
- LS-Fit (Linear Band Prediction)
- Matched Filtering
- Mixture Tuned Matched Filtering (MTMF)

- Multi Range Spectral Feature Fitting
- Spectral Feature Fitting

## Spectral Libraries

Anomaly Detection workflow

Build spectral libraries

Collect endmember spectra from various sources

Drag and drop spectral curves between plot windows

Export spectral library data to:

- ASCII
- ENVI spectral library file (SLI)

Import spectra from:

- Analytical Spectral Devices (ASD) spectrometer files
- ASCII files
- Other spectral libraries
- ROI means
- Spectral profiles and plots

Perform dimensionality expansion on spectral libraries

Resample spectral libraries to match:

- ASCII wavelength file
- Response of a known instrument
- User-defined filter functions
- Wavelengths of a specific image input file

Pre-built laboratory spectra of vegetation and man-made materials:

- John Hopkins University
- NASA Jet Propulsion Laboratory
- U.S. Geological Survey

View spectral library files:

- ASD
- ENVI SLI
- THOR Metadata Rich Spectral Library (MRSL)

## SPEAR Tools

Spectral Analogues

Watercraft Finder

## Statistics

---

Calculate global spatial statistics:

- Geary's C
- Moran's I
- Semivariance

Calculate local spatial statistics:

- Anselin Local Geary's C
- Anselin Local Moran's I
- Getis-Ord Local  $G_i^*$

Create 2D scatterplots

Create rasters of pixel statistics:

- Basic: Minimum, maximum, mean, standard deviation
- Kertosis
- Mean absolute deviation
- Skewness
- Sum
- Sum of squares
- Variance

Get band statistics:

- Basic: Minimum, maximum, mean, standard deviation
- Histograms

- Covariance

Get classification accuracy metrics:

- Confusion matrix
- Errors of commission
- Errors of omission
- Kappa coefficient
- Overall accuracy
- Producer accuracy
- User accuracy

Get classification image statistics:

- Basic: Minimum, maximum, mean, standard deviation
- Covariance
- Histograms
- Pixel count
- Percentage per class

Get quick statistics from images:

- Histograms
- Minimum
- Maximum
- Mean
- Standard Deviation

Get ROI statistics:

- Basic: Minimum, maximum, mean, standard deviation
- Histograms
- Pixel count per ROI

Save band statistics to text files

Save classification statistics to text files

## Target Detection

---

### Target Detection Wizard

Apply MNF dimensionality reduction

Choose target detection methods:

- Adaptive Coherence Estimator (ACE)
- Constrained Energy Minimization (CEM)
- Orthogonal Subspace Projection (OSP)
- Matched Filtering (MF)
- Mixture Tuned Matched Filter (MTMF)
- Mixture Tuned Target-Constrained Interference-Minimized Filter (MTTCIMF)
- Spectral Angle Mapper (SAM)
- Target-Constrained Interference-Minimized Filter (TCIMF)

Filter targets

Import target and background spectra from:

- Individual spectral plots
- ROIs
- Spectral libraries
- Statistics files
- Text files

Open and preview rule images

Select atmospheric correction methods

Export results to:

- ROIs
- Shapefiles

View output statistics and report

## SAM Target Finder with BandMax

Import target and background spectra from:

- ASCII files
- ASD files
- Endmember Collection files
- ENVI Vector Files (EVF)
- ROIs
- Statistics

Select band subsets for suppressing background signatures

Use the SAM algorithm to find targets

Examine output rule and classification images

## THOR Target Detection

Apply dimensionality reduction

Choose target detection methods:

- ACE
- CEM
- MF
- Normalized Euclidean Distance (NED)
- OSP
- SAM
- SID
- Spectral Similarity Mapper (SSM)
- TCIMF
- Unsupervised Water Detection (UWD)

Clump and sieve results

Export results to:

- ENVI Vector Files (EVFs)
- KML files
- ROIs
- Shapefiles

Import target and background spectra from:

- Metadata Rich Spectral Library (MRSL) files
- ROIs
- Spectral libraries

Process single files or batch-process multiple files

Select atmospheric correction methods

Select signature matching methods

## Time Series Analysis

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### Raster Series

Animate raster series

Build raster series from:

- MIE4NITF camera frames
- Multi-page TIFF files
- Multiple images, with or without time metadata
- Proba-V video files
- SkySat-1 video files
- Video files

Create time series profiles

Regrid raster series by:

- Index number
- Intersection of images
- Union of images

## Temporal Cube

Build multiband raster from multiple raster files

Each band in the temporal cube represents a different date/time

Perform classifications or other analysis on temporal cube raster

## Topographic Modeling

---

Apply topographic shading using color spaces:

- HLS
- HSV
- RGB

Blend color DEMs with topographic features using the Topographic Shading Tool

Create 3D surface views of elevation and image data

Create classification images of morphometric features:

- Channel
- Pass
- Peak
- Pit
- Plane
- Ridge

Create digital surface model (DSM) images from overlapping stereo images (requires the ENVI Photogrammetry Module)

Create shaded relief images from digital elevation data

Create shapefiles of contour lines from full-resolution digital elevation data

Conduct viewshed analysis using:

- Interactive Viewshed Tool using:
  - A single observer point that can be moved around the image.
  - One or more drawn paths that contain multiple observer points along the path.



- One or more drawn areas that contain multiple observer points inside the area.
- ENVI LiDAR

Convert vector topographic maps into DEMs

Display a global Natural Earth I shaded relief dataset, included with ENVI

Extract DEMs from aerial and satellite imagery (requires the ENVI DEM Extraction Module):

- Requires stereo imagery with RPCs
- Create epipolar images
- Use the 3D Epipolar Viewer to extract elevation values from stereo imagery
- Match image features
- Geocode DEMs to epipolar projections to standard map projections

Extract topographic modeling features from digital elevation data:

- Aspect
- Cross sectional convexity
- Longitudinal convexity
- Maximum and minimum curvature
- Plan convexity
- Profile convexity
- Root mean square (RMS) image
- Slope

Fill bad values in digital elevation data

Perform terrain categorization (TERCAT) using SPEAR Tools

Rasterize ASCII point data

Use the GMTED2010 dataset (included with ENVI) for topographic applications

## Vectors and GIS Support

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Also see [Supported Vector Formats](#).

Convert ENVI Classic Vector Files (EVFs) to shapefiles

Create masks from vectors

Create new vector layers from ASCII and CSV files:

- Multi-point
- Point
- Polygon
- Polyline

Create shapefiles:

- From bounding boxes
- From centroids
- From classes
- From feature counts
- From filtered attribute records
- From smoothed polylines and polygons
- From ROIs

Display world vectors:

- Airports
- Coastlines
- Countries
- Geographic lines
- Minor islands
- Populated places
- Ports
- Rivers
- Roads
- States/provinces

Download and display OpenStreetMap® vectors

Edit vector layer properties

Group and ungroup vectors

Interactively draw vectors:

- Multi-point
- Point
- Polygon
- Polyline

Interactively edit vectors:

- Add and delete polyline and polygon vertices
- Delete records
- Group and ungroup records
- Join polylines
- Merge and split polylines and polygons
- Move polyline and polygon vertices
- Rectangulate polygons
- Remove polygon holes
- Smooth polylines and polygons

Merge vectors

Reproject vectors to different coordinate systems

Save vector symbology to file

Spatially subset images from vector files

Upload vectors to ArcGIS Portal

Work with attributes:

- Add columns
- Create new attribute records
- Convert attributes to ROIs
- Convert attribute records to feature counts, one ROI, separate ROIs
- Edit display properties (color, line width, etc.)
- Filter records by attributes
- Import from ASCII, CSV, EVF, geodatabases, shapefiles
- Remove columns

- Replace multiple cells with one value
- Save records to shapefile
- Select and edit records
- View attribute tables

## Vegetation Analysis

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Agricultural Stress

Fire Fuel

Forest Health

Vegetation Analysis workflow